Cr_2O_3 карбідом Cr_3C_2 (див. рис. 1) цілком природно через розведення вуглецевовмістких газів сумішшю H_2 – H_2O. Водень входить в комплексне відновлення Cr_2O_3 ще раніше – при температурі ~ 1130°C. Таким чином існують термодинамічні передумови для інтенсифікації вилучення хрому з оксидних фаз за рахунок карбіду Cr_3C_2 за участю водню.

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RESEARCH OF THE UNLOADING OF CHARGE MATERIALS FROM THE CONE VALVE OF THE LOADING DEVICES OF THE BLAST FURNACE

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The method for determining the parameters of the output of charge materials from the hoppers of the cone-free charging devices of blast furnaces can be used to calculate the consumption of charge materials when the conical charging device of the blast furnace leaves the large cone

[1, p. 192]. In this case, the outflow slot will be ring-shaped. The main parameters influencing the outflow of the material are the average circumference of the annular gap and its thickness. The distribution of the zones of the state of the material during the outflow are identical both for the hopper and for the cone loading device with the only difference that the sections are located on the cone around the circumference. It should be remembered that the gap ring in our case is not a flat geometric figure, it is a surface of a truncated cone of relatively low height. The charge consumption from a large cone can be represented as

$$Q = \frac{2}{3} l \delta^{1,5} \sqrt{g} \frac{1}{\sqrt{1+\zeta}} \frac{K_1^{1,5}}{(K_1 - \chi')} \left[1 - \left(\frac{\chi'}{K_1} \right)^{1,5} \right], \quad (1)$$

where l - length of the working perimeter of the large cone of the blast furnace charging device, m;

δ – the width of the gap for the pouring of charge materials, m; g – acceleration of gravity, м/с2;

$$K_1 = \frac{1}{2}\left(f + \sqrt{1+f^2} \right),$$

where

f – coefficient of internal friction of bulk cargo;

$$\chi' = f + \frac{1}{f} - \sqrt{1+f^2}.$$

ζ – the coefficient of local losses during the movement of bulk cargo in the collapse zone, characterizing the loss of mechanical energy of the flow of bulk cargo when particles collide with each other [2, p. 164]. In fig. 1 is a diagram for determining the size of the gap when opening the large cone of the blast furnace charging device.

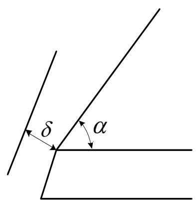

Fig. 1. Scheme for determining the gap of pouring charge materials from the large cone of the blast furnace charging device

$$\zeta = K_1 K_2 \frac{k^2 d^2}{a^2}, \tag{2}$$

where k – dimensionless coefficient depending on particle shape (k = 10-13);

K2 – some dimensionless coefficient depending on the conditions for the outflow of bulk cargo from the bunker (direct or lateral outflow of bulk cargo from the bunker, the shape of the outlet channel), determined from the experiment.

d – average particle diameter of bulk cargo, m

However, it should be remembered that the value when materials are poured from a large cone changes over time.

Therefore, in the calculations, it is necessary to apply the functional dependence of the gap on time. Based on literature data [3, p. 104], experimental studies and instructions for the operation of charging devices, it was found that the average speed of lowering a large cone is 100 mm / s. Taking into account the uniformity of the movement of lowering the cone, it is proposed to represent the vertical movement of the cone in the form of the following dependence:

$$S(t) = 0,1t \tag{3}$$

where t – time, c.

Taking into account (3) and Fig. 1, the dependence of the gap on time will be as follows:

$$\delta(t) = 0,1t\cos\alpha \tag{4}$$

Taking into account (3) and (4), (1) after transformations takes the form:

$$Q(t) = \frac{\Omega l t^{1,5} \cos^{1,5}\alpha}{\sqrt{1 + \frac{\theta}{t^2 \cos^2\alpha}}}, \tag{5}$$

where

$$\Omega = 0,067 \cdot \frac{K_1^{1,5}\left(1 - \left(\frac{\chi}{K_1}\right)^{1,5}\right)}{(K_1 - \chi)}, \tag{6}$$

$$\theta = 0,0417 k^2 d^2 \frac{K_1}{2}. \tag{7}$$

Thus, the dependence of the volumetric flow rate of charge materials falling from the large cone of the blast furnace charging device at a specific time has been obtained. By integrating (7) over time, one can obtain an analytical dependence of the actual charge consumption for the entire time interval of pouring the charge into the blast furnace. However, the anti-derivative function in direct integration turned out to be very inconvenient for practical calculations, it was decided to calculate a definite integral of expression (7) with a step of 1 second and display the dependence on the graph. Figure 2 shows the graphical dependence of the total consumption of coke with a size of 50 and 80 mm over a period of time for a large cone with a diameter of 5000 mm. The abscissa shows the time in seconds, the ordinate shows the flow rate in cubic meters. Solid curve for 50 mm coke, discontinuous for 80 mm particle size, respectively, circles show experimental data at the plant. These data correlate well with experimental studies carried out by the Institute of Ferrous Metallurgy of the National Academy of Sciences of Ukraine for blast furnace No. 5 of the Yenakiieve Metallurgical Plant [4, p. 74].

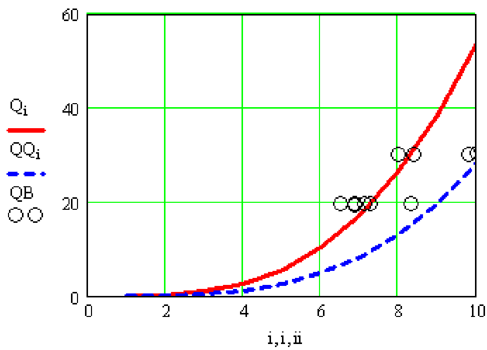

Fig. 2. Dependence of the total flow rate for the time interval of opening the large cone

Thus, analyzing the material given above, we can conclude that the method proposed by the author for determining the consumption of charge material passing through a cone gate as a function of time describes the process of charge expiration with sufficient accuracy and can be applied in the development and operation of cone loading devices of modern blast furnaces.

A distinctive feature of the new technique is the ability to take into account not only the geometric and kinematic parameters of the conical valve, but also the physical and mechanical characteristics of the particles of the charge material. In the considered method [5, p. 145] these characteristics are indirectly taken into account by the expiration coefficient, which is recommended to be taken in the range of 0.4-0.6. However, this does not fully allow taking into account the parameters of the charge, which in modern conditions are constantly changing.

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